THE FIRST UNIVERSITIES

Studium generale *and the origins of university education in Europe*

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CHAPTER I

The classical inheritance

Today the oldest universities in Europe trace their history back to the middle ages, and they generally date their origin to a time around the end of the twelfth century. However, this has often been difficult to determine precisely, because the sources are sparse and the concept of a university itself was still not clear at that time. In medieval times people were not satisfied with this kind of dating. Historians of the past in England were convinced that the university in Oxford had already been founded in the ninth century by King Alfred the Great, and on the continent people regarded the university in Paris as a direct descendant of Plato's old Academy in Athens, which they thought had been moved to the French capital via Rome. Never mind that such ideas are chiefly evidence of the small critical sense in certain medieval historians – at the time they contained a proper understanding of the fact that the universities had roots in the past which went back as far as the great schools of classical antiquity. Today the prehistory of the universities can be traced back even further, considering that there were schools among the pre-Grecian cultures in the Middle East as well. These schools gave instruction, advanced for the conditions of the time, to select groups of students who could later count on entering particular positions in society in order to apply their special knowledge there.

There is no real knowledge of when human society reached such a stage in its development that the conditions and requirements for real school education existed. Even in the most primitive societies it was of vital importance that certain knowledge and accomplishments could be passed down from one generation to the next, but in spite of this, real school education could have existed only in the first settled urban communities. Strong concentrations of population presupposed a central authority in the form of a town council, or a royal power, equipped with administrative organs to attend to the

common tasks of society. Collecting taxes and duties required a class of administrators with specialised knowledge of accounts, no less of writing too, just as there were well-defined systems for weights and measures of various wares. Furthermore, a permanent administration made chronology and a calendar necessary; in most cases the calendar was developed on astronomical principles which were often closely associated with the religious cult of the day. As all these things in the beginning must have been dark mysteries for the ordinary man, skilled specialists probably attended to them. What is immediately clear is the essential interrelationship between school bodies and the bureaucracy, and this is confirmed by what we now know of the best-known urban cultures of the ancient Middle East.[1]

In this way we are relatively well informed about education in ancient Egypt, where boys were normally educated at home, until they began to learn a trade as apprentices at the age of ten. Various Egyptian texts have been preserved, in the form of 'Books of Wisdom' containing a father's advice to his son on the principles of leading a happy life as a useful member of society. This led to the well-to-do classes of society sending their sons to proper schools to learn reading, writing, and counting, something to which numerous *ostraka*, or inscribed potsherds with the exercises and tasks written on them, can testify. Girls seem not to have had access to these schools, in which special emphasis was also placed on literary proficiency; mathematics played a subordinate role, and sport or other physical education was left out altogether.[2]

A more specialised teaching went on nonetheless in the so-called 'houses of life', which had several different functions. Here professional writers were trained and religious texts for use in temples were copied, not to mention the *Book of the Dead*, which was reproduced in thousands of copies. Here too proper theological teaching was carried out, just as the very highly developed Egyptian medicine was associated with these institutions and with the sanatoriums that in the later period could often be found attached to the temples.[3]

[1] General works of reference for this chapter are Marrou, and W. F. Albright, *From the Stone Age to Christianity*, 2nd edn, Baltimore, 1946.

[2] On the Books of Wisdom and other Egyptian literature see E. Wallis Budge, *The Literature of the Ancient Egyptians*, London, 1914, and the two works by A. Erman, *Die Literatur der Aegypter*, Leipzig, 1923 and *Die Religion der Aegypter*, Berlin, 1934. See also A. Erman and H. O. Lange, *Papyrus Lansing. Eine aegyptische Schulhandschrift des 20. Dynastie*, Copenhagen, 1925.

[3] The best general introduction to Egyptian and Mesopotamian mathematics and astronomy

One text of great significance for our knowledge of how Egyptians were educated is the *Rhind Papyrus*, which was found near the Ramesseum in Thebes in 1858 and is now kept in the British Museum.[4] This is a papyrus scroll a good 5.5 m long and 33 cm broad, containing about 100 different mathematical texts. It has as its title 'Accurate Arithmetic: Introduction to the Knowledge of All Existing Things and All Dark Secrets', which clearly shows that we are dealing with a textbook. From the preface it appears that the book was finished in the thirty-third year of the reign of A-User-Re (one of the Hyksos kings), by the scribe A'h-Mose, from an exemplar in the form of an older text from the time of King Ne-Ma'et-Re. This man is identical with one of the last pyramid-builders in the twelfth dynasty, Amenemhed III, which means that the text really gives us a glimpse of Egyptian mathematical education about 2,200 years before Christ.

The *Rhind Papyrus*, first of all, contains purely mathematical tables for use with fractions, together with a series of practice examples all worked out. Some of these are of purely abstract character, while the majority are couched as problems of many different kinds. Acreages are worked out, the cubic content of corn silos, the division of bread among labourers, and much besides. The form of the examples itself shows the *Rhind Papyrus* being what could be called a Teacher's Manual. An equivalent volume for the pupil is the *Moscow Papyrus*, which derives from about the same period. This contains exercises of largely the same types, often with the teacher's note 'You have got it right!'

Such texts could only have been interesting to a certain group in society – people learning how to survey land, how to gather in the crops and store them, and how to administer and supply working shifts. In other words it is a matter of the Egyptian administrators or 'scribes' who in this way received a regular training related to their future occupations. The existence of real schools for administrators can therefore be inferred from as early as the third millennium BC, with members as guardians of the 'dark secrets' represented in the *Rhind Papyrus*, in clear contrast to the more literary and elementary education of general schools. These schools for administrators aimed directly at specialised knowledge beyond the horizons of the

is O. Neugebauer, *The Exact Sciences in Antiquity*, Copenhagen, 1951, reprinted New York, 1962.

[4] A. B. Chase and R. C. Archibald, *The Rhind Mathematical Papyrys, 1–2*, Oberlin, Ohio, 1927–9.

generally educated. With their practical outlook, such schools were integrated into Egyptian society on one hand and formed a clear basis for class privilege on the other. They gave their pupils qualifications for power and influence in society, and archaeology has uncovered numerous funeral monuments which testify to the high social position of the scribal class. A text from about 1300 BC shows us the scribe Akhtoy in the process of explaining to his son Pepi the high rank of the scribe, which is glorified at the expense of physical labour. Don't be a farmer! Don't be a baker! Don't be a priest! Don't be an officer! Be a civil servant! – this is advice which crops up again and again in these texts as an early example of academic snobbery.

From the ancient Mesopotamian cultural area a huge amount of material survives on clay tablets. The oldest of these date from about 3000 BC and are written in the original pictographic script of the Sumerians. In the course of the following millennium this was developed into the wedge or cuneiform script that was eventually used across large parts of the Middle East by Babylonians and Assyrians, Hittites and Persians. Most of this material is made up either of religious texts or of documents to do with practical life – deeds, accounts, reports from civil servants, laws and statutes, and proclamations and the like. Other known texts deal with mathematics, with the memorisation of procedures for solving problems of largely the same practical kind as those we know from Egypt, even if Babylonian mathematics in time became far more advanced. Among the mathematical texts of the later period (the age of the Persians and Seleucids), there are several with astronomical tables and calculating procedures of importance to the calendar and astrology. In Mesopotamia too, therefore, it is clear that schools existed which gave advanced teaching to different categories of future officials.

Life in such a school is described in a Sumerian text from about 2000 BC, of which many copies were made in later times. It consequently enjoyed a certain popularity and can therefore be taken as typical.[5] The many Akkadianisms in the text show that it was written by an Akkadian student, but in the Old Sumerian language, which enjoyed a status as a language of learning similar to that of Latin later in Europe. The student leaves home in the

[5] S. N. Kramer, Schooldays. A Sumerian Composition Relating to the Education of a Scribe, *Journal of the American Oriental Society* 69 (1949), 199–215.

morning bringing his lunch which is later eaten in school. The headmaster is a 'school father', and mentioned in the text is also one teacher in Sumerian and another in arithmetic. Lessons take the form of the copying of already existing clay tablets, and the subjects are Sumerian, arithmetic, and book-keeping. A porter, a classroom pedagogue, and a playground superintendent maintain strict discipline – the student is lashed seven times a day for a series of different offences that school pupils would still recognise today: arriving late in the morning, talking in class, getting up without leave, leaving the school grounds without permission, and skimping written work. Only towards evening does the student trudge wearily home, making a report of the day's work to his father (formerly an official himself), eating his supper and going to bed early so as to be fresh the next morning. On one occasion the teacher is invited home when the father wishes to put in a good word for his son who would like to be a perfect scribe and a learned man – cleverer than his schoolmates, even those from the royal house.

It is interesting to note that Jewish society in Israel did not distinguish itself from the neighbouring countries where the existence of an educated scribal class was concerned. This social class has left a literature still partly preserved in the Old Testament as the Book of Proverbs, Ecclesiastes, the Book of Wisdom, and the Wisdom of Jesu Sirach. This class was particularly closely bound to the court and also sought to keep its privileges by running schools and training its own children. Its literary legacies as a whole are quite without any philosophy. For example, the Book of Proverbs can be summarised as a handbook for the perfect functionary, in that it codifies, in aphoristic rules of conduct developed from day-to-day experience of life, the traditional wisdom of life on which the ideology of this class was based. That Israel in this way was an element in the general cultural pattern of the Middle East also appears in the straight borrowing of a passage in Proverbs (22: 17–23: 11) from the Egyptian Book of Wisdom of Amenemopes of *c.* 1100 BC. Clear traces of Hellenistic cultural influence can be found in later Hebrew works. Now and then a clear sign of class-consciousness can be traced in the way the work of the scribe is glorified and manual trades are despised. In connection with religious shallowness, this is surely the background to the polemic that the prophets directed at the scribes. Jeremiah, for example, has little time for their pretended wisdom or for the court circles that made use of them.

Seen from the point of view of education, ancient Middle Eastern societies can be comprehensively labelled scribal cultures.[6] It was the scribe who received the highest education. It was he who mastered the secrets of the arts of writing and arithmetic and thereby had access to high offices bringing power and social position. He was conscious of his class, often looked down on simpler manual workers and sought to pass on the privileges of his rank to his children with the help of special schools of advanced learning with a practical emphasis on the needs of the next generation of administrators, in such a way that a conflict of principle between higher education and the rest of society would have been unthinkable. The integration of education into the state was complete.

If we now turn to the culture of the Greeks, we find a totally different picture with far more details because of more numerous and better-researched sources. It is not hard to point out a series of features which divide Middle Eastern scribal cultures from Greek learning of the sixth century BC onwards. The learning in question is demonstrably that of the more or less loosely knit city states on which the Greek world was built. The ideological backgrounds were significantly different. The scribal training of the Orient had a strongly pragmatic character and was aimed directly at maintaining a status-conscious class of administrators in society. Yet among the Greeks there was an idea of an education that was in principle open to all members of society. This was not carried out consistently, since slaves had no civil rights and got no regular education, and similarly girls usually got a less comprehensive education than boys. But this does not change the fact that the idea of an education as the right and duty of all (free) citizens is first found among the Greeks. This presupposed a view of society according to which each citizen must be ready to take part in the government of the state by appearing in the popular assembly, while the idea of a special class of administrators, by and large, was strange to the Greeks.

With this in mind it is understandable that the term the Greeks used for education – *paideia* – was synonymous for them with culture and civilisation.[7] The Greek *paideia* distinguishes itself from the pragmatism of the East by being far more comprehensive. Where the Egyptians and Babylonians only aimed at skills and accomplish-

[6] The term 'scribal culture' was coined by Marrou, p. 19.

[7] On Greek education in general see W. Jaeger, *Paideia. Die Formung des Griechischen Menschen*, vols. I–III, Berlin–Leipzig, 1934-47.

ments that were of direct benefit for an official, the Greeks laid stress on an upbringing that could be measured as much by intellectual as by artistic and physical standards. The whole man was to be shaped, physically through gymnastics and sport, artistically through dance and singing, intellectually through such elementary subjects as reading, writing, arithmetic, and more advanced skills in literature and philosophy. For this reason Cicero was not mistaken when he later Latinised the Greek *paideia* to the Roman *humanitas*. This applies despite the fact that not all Greek states put equal stress on the different elements of their education. In Doric societies such as Sparta and Crete, physical training dominated with strict discipline and overt military aims, while the intellectual and artistic side had far greater meaning in the Ionic cities on the coast of Asia Minor, and later in the Attic society of Athens and elsewhere on the mainland. This also decided the different ways in which schools were run: as state institutions in Sparta, but usually as private schools in Athens and other places.

In the course of the fifth and fourth centuries BC there was a series of important innovations in Greek schools. With the raising of the intellectual level and the growth of knowledge in many areas, special schools grew up here and there which gave advanced education in one particular subject. Famous in this context are the school and hospital associated with the temple of Asclepius in Epidaurus, and the Hippocratic school of medicine on the island of Cos, founded by Hippocrates (469–399), the most famous physician of the Greeks. The greatest mathematician of this period, Eudoxus of Cnidus (*c.* 408–355), had his own school in Cyzicus, which he moved to Athens in 368 BC. In opposition to this specialisation came the sophists in the fifth century, who tried to deal with the advances made in learning by thrashing out difficult problems with the aid of rhetorical methods but without a sufficient theory of knowledge. This was the context of the critique which Socrates (469–399) made and of his attempt to build a firmer foundation of knowledge. How fine the fruits of traditional learning could also be, can be seen at about the same time in Socrates' younger friend Isocrates (436–338), who gave his pupils in his school of rhetoric in Athens a thorough preparation for a practical life in politics.

The schools in Hellas proper at this time were not the only contribution to a system of education that in relation to the Middle East was new and progressive. In the Greek colonies in Italy and

Sicily we find from about 500 BC 'the so-called Pythagoreans' (the term is Aristotle's), who lived, in any case to start with, in closed societies of a very special character. Their ideology is not known in all its details because it was kept a strict secret to all but initiates. Their societies may be regarded as religious orders or brotherhoods; this was not peculiar, given that Greek schools in Hellas too were frequently constituted as cult communities. But the Pythagoreans marked themselves out from other brotherhoods by making the purification of man the aim of their society's whole existence. Again one thinks of the whole person, with the body purified through various forms of asceticism, the soul through instruction. The initiates divided themselves into two groups, of which the 'acousmaticians' just sat by and listened while the 'mathematicians' got something of the higher mysteries. The latter word comes from the Greek verb *manthanó*, 'I learn'. Thus the derived form indicates those who had learnt something, namely Pythagorean science. The connection with the later meaning of this word is evident from the list of disciplines standing foremost on the list. It is said in a statement of Archytas the Pythagorean (about 400–350 BC) that mathematicians had 'entrusted us with clear knowledge of the speed and motion of the stars and of their rising and setting, and of geometry, arithmetic and spherics, and not least of music; for these studies have proved to be sisters'.[8]

With these we meet subjects for the first time that later under the name of the Pythagorean quadrivium would come to play such a prominent role in the university curriculum. *Quadrivium* means 'the fourfold way'; incidentally the same gloss is first used in Boethius' *Arithmetica*.[9] Diagram 1 shows a scheme of these disciplines.

	in the abstract	in nature
discrete numbers	arithmetic	music
continued dimensions	geometry	spherics (astronomy)

Diagram 1

[8] H. Diels, *Die Fragmente der Vorsokratiker*, ed. W. Kranz, vol. 1, p. 429, Dublin–Zurich, 1966. The quotation has survived in Porphyry's commentary on Ptolemy's *Harmonics*. Pythagorean doctrine can be studied in the sources and commentaries in G. S. Kirk and J. E. Raven, *The Pre-Socratic Philosophers*, Cambridge, 1962, chs. 7–9 and 13. See also W. Burkert, *Weisheit und Wissenschaft. Studien zu Pythagoras, Philolaos and Platon*, Nuremberg, 1962.

[9] Boethius, *De Institutione Arithmetica*, I, 1, ed. G. Friedlein, Leipzig, 1867, p. 1.

That these studies are sisters presumably means that certain relations were found to exist between them as shown in the diagram. That together they came to form the nucleus of the secret lore of the Pythagoreans shows how much weight was placed here on the mathematical subjects. This is in harmony with Aristotle's account of the Pythagoreans' faith in an inner, mathematical structure of the universe: the nature of things is in numbers. So it seems that the Pythagoreans wished to cleanse the soul – of its congenital darkness and ignorance – through a concept of nature that according to their first principles had to be 'mathematical'. Thus a new element was added to the Greek ideal of education that would later have the most far-reaching consequences.

The Pythagoreans represented something really new in the field of education. Just as the Egyptians and Babylonians did, they reserved education for a limited circle; but this does not seem to have formed any real class of society with special economic privileges, rather a circle of initiates who sought deliverance through study. Whereas the training of the Orientals had been practical, pragmatic, and directed to the general needs of society, that of the Pythagoreans was theoretical, idealistic, and directed to the spiritual needs of a closed and private group. And while both they and their fellow Hellenes elsewhere in Greece focussed their system of education on the whole man, this took place in Hellas with the aim of giving all citizens equal opportunities in national life, whereas among the Pythagoreans it led to the initiates of the inner circle becoming superior to those excluded from it. The ensuing tension was resolved one way or another at the time when the Pythagorean system became known in Athens.

This happened with Plato (427–347), who was not only a pupil of Socrates and had links through him with the traditional learning of Athens but had also become a friend of Archytas when, after Socrates' execution in 399, he left Hellas to visit Sicily and Egypt.[10] When he returned and in the year 393 founded his Academy in Athens, two traditions were united here in a way that was of epoch-making significance. Plato's Academy was a higher institution of learning that partly required of all its pupils some preparatory special training, partly presumed a common Greek education with

[10] Among the innumerable works on Plato it is useful to consult A. E. Taylor, *Plato, the Man and his Work*, 3rd edn, London, 1929, and J. E. Raven, *Plato's Thought in the Making*, Cambridge, 1965.

gymnastics for the body and music for the soul. In addition, a grounding in mathematics was required in accordance with the inscription over the gate of the Academy: 'No man unskilled in geometry enters here.' However, this famous criterion of entry was first mentioned by the Byzantine author John Tzetzes in the twelfth century and is in this way not entirely trustworthy. Certainly the development of mathematics itself had made an overwhelming impression on Plato and was one of the most important prerequisites for his views on metaphysics and the theory of knowledge: for in mathematics the proofs were secure, the doctrines true, so that true knowledge was not an unobtainable ideal as the sophists had claimed. On the other hand, mathematical truths are abstract and never wholly obvious in that material world to which only the senses have access; such truths are accessible only to the reason that is able to contemplate them in a distinct and immaterial world of ideas in which all changeable, visible, and transitory things have their own unchangeable, immaterial, and eternal models.

All this bears witness to the general importance of mathematics for Plato. Concrete Pythagorean tenets turn up, for example, in the *Timaeus*, a dialogue on the making and structure of the world. On the other hand, Plato's literary form in his extant writings, with the consistent application of the dialogue form, is clearly taken from an older Greek tradition and from Socrates himself.

In its external organisation the Academy was constituted as a cult fellowship for the purpose of venerating Apollo and the muses, something that was also in keeping with Greek tradition. Pythagorean was the community life of teachers and pupils, with common meals and ascetic practices, the latter being expected to cleanse the soul and further the understanding. The form of instruction itself was defined in a strongly active way. It consisted not only of lectures but also of discussions between teachers and pupils which in a recurring way regularly culminated in festive symposia on declared themes.

As regards the immediate object of this training, however, Plato was undoubtedly more a Hellene than a Pythagorean. He wished first and foremost to educate his pupils to be good citizens and capable politicians in general society, and many of them did in fact play a role in the public life of Greece. How penetratingly Plato thought of the problems of education can best be seen from two dialogues, *The Republic* and *The Laws*, in which he discusses the

possibility of a human society entirely ruled by the laws of reason. In these writings he gives a very prominent place to the debate on the problems of educating the young, in the first known attempt to work out a proper pedagogic theory that was intimately linked with the ideal form of society portrayed in these seminal works.

This theory builds first and foremost on a sharp critique of the existing Greek society, in its democratic, oligarchical, or tyrannical forms. Nowhere does reason rule alone, and the few philosophers there are, moreover, are reckoned to be ineffective. This state of affairs may be changed; 'if the philosophers do not become kings in the state, or those who now bear the name of kings and rulers do not begin to occupy themselves with philosophy in a genuinely satisfactory way, and if this union of power and political philosophy does not succeed, then, my dear Glaucon, there is no chance of evil ever being brought to an end in the cities, nor, I believe, in humanity', says Socrates in *The Republic*.[11] 'No city or government can ever be perfect', it is said further, 'until these philosophers that are so few in number and unspoiled, and yet are called ineffective creatures, are forced by some happy chance (whether they will nor not) to take power in the city, and the city forced to obey them.'[12]

Besides his ruling philosopher class, Plato furthermore imagines the republic as made up of two groups, partly soldiers (guardians), partly citizen tradesmen, of course in addition to slaves. He outlines a very detailed training for all three groups, one of which starts early in childhood where the first skills are inculcated in a sort of nursery pedagogics with play and games. To this the indispensable subjects gymnastics and music are added, with all that this implies, and at some higher stage the pupils receive an adapted form of teaching of a more abstract kind in which the Pythagorean quadrivium, with its mathematics and astronomy, plays a major role. Special significance is attached to these subjects among free people, for they sharpen the reason and at the same time raise the soul from the low, material world to a contemplation of the eternal truths where wisdom begins. Later the most able of all are chosen for a protracted in-service training which prepares them directly for the leading posts in their society. Also the training of teachers is taken into consideration.

By our lights, Plato's ideal society is a rather harsh dictatorship in which all human matters are regulated in the smallest detail and in

[11] Plato, *The Republic*, v, 8 (473c). [12] Ibid. vi, 12 (499b).

which the poets, for example, 'must not compose anything that conflicts with what is law and order in the republic or with what is beautiful and good'[13] – or publish their works before they are approved by special censors. But this did not prevent Plato from putting two new ideas into circulation which meant a complete break with tradition and became a lodestar for the ages to come. In *The Laws* Plato says: 'It shall not be so, that teaching is only sought by those whose fathers wish it, yet is neglected by those whose fathers will not have them taught; but', so he says, 'each man and each boy shall so far as is possible submit to compulsory education, for they belong more to the republic than to their parents. Regarding women, also, my law means of course exactly what it does as regards the male sex: they too shall take part in just as many exercises.' And further: 'Quite foolish is that which goes on in our countries, that not all men and women are agreed on occupying themselves with all their power with the same things.'[14]

These were new thoughts. Quite clearly the principle that education should be public and obligatory had been put into practice in Sparta; but in Athens and most other states it was still private and voluntary. Completely new, however, was the proposition that education and employment should be open to women to the same extent as to men. In both points Plato was therefore ahead of his time – so much so that his idea cannot yet be said to be realised or even recognised everywhere today.

Throughout more than 900 years Plato's Academy stood out as the first example in antiquity of an institution with an education at once socially useful and generally humane as its aim. It has since often been considered the world's first university, and as the hearthstone of the Platonic tradition in philosophy the Academy has also meant more for European thinking than most of the other schools either before or since. Its strength was the acumen and consistency with which fundamental problems of science and humanity were set out in debate. But its weakness was precisely the philosophical dialectic that was the tool of the Academy's method in all areas without being a sufficient basis for a solid expansion of scientific knowledge. In our eyes the Academy therefore needed just the supplementation it got when Plato's former pupil Aristotle (384–322) returned to Athens in 335/334 to set up his own school, the Lykeion

[13] Plato, *The Laws* VIII (801c). [14] Ibid. (804d).

or 'peripatetic' school, which he directed for the next thirteen years, until, as a Macedonian, he had to leave Athens on political grounds, to die in Chalcis only a year later.[15]

The Lykeion was formally a typical Greek-Athenian private school and was organised just as the Academy had been, as a cult society, containing a temple with consecrated offerings, and a colonnade with statues of the muses. The statutes worked out by Aristotle prescribed a life of perfect order with common meals, a monthly symposium, and the like. But the spirit was other than that at the Academy: where Plato had sought to educate by teaching, Aristotle wished in addition to train by research. He also saw as his aim the development of a good and harmonious member of society, but the methods were different. The relevant subjects are pursued, in Aristotle's view, not only through theoretical reflections on basic problems of philosophy, but also by direct experience through exploration of both natural phenomena and the structure of society. So he equipped his school as a real research institute with ordered collections of scientific material. In the so-called Museion there was an extensive manuscript library and a collection of teaching materials. In a colonnade there hung maps of the regions that Greek geographers and other travellers had explored, and there frequently came to the Lykeion shipments of hitherto unknown animals from the East; some of them were gifts from Aristotle's former pupil Alexander the Great, who did not forget to send home to his teacher new material for research from his remote military expeditions. All this now meant that for the first time scholarly research appeared as an activity in its own right at an institute of learning. The immediate consequence of this was that while all scientific work had previously been carried out under the common name of philosophy, a series of subjects now broke away as special topics of research with the resulting establishment of a series of independent sciences.

Aristotle personally completed a programme of research with his treatise *On the Natural History of Animals*, in which he classified and described about 540 different species of animal; with this work zoology was founded as a science, just as Aristotle's description of the development of the chicken can be said to be the start of embryology.

[15] The most recent general introduction to Aristotle is the article on Aristotle in *DSB*, vol. 1, pp. 250–81. See also W. Jaeger, *Aristoteles*, Berlin, 1923 (English transl. Oxford, 1934); I. Düring, *Aristoteles, Darstellung und Interpretation seines Denkens*, Heidelberg, 1966; G. E. R. Lloyd, *Aristotle, the Growth and Structure of his Thought*, Cambridge, 1968.